REMARKS/ARGUMENTS

Upon entry of this amendment, claims 1, 4, 5, 8, 9, and 13 will be amended. Claims 2, 3, 6, 7, 16 and 18-28 will be cancelled, either previously or by this present amendment. New claims 29 and 30 are presented for the Examiner's consideration. Therefore, claims 1, 4, 5, 8-15, 17, 29 and 30 will be pending upon entry of this amendment.

Claim 1 is amended to incorporate the features of former claims 3 and 7 and former claims 3 and 7 are cancelled. Claim 1 is also amended to define the exposing step as "directly exposing" and to remove the feature of the solvent being selected from the group consisting of alcohols, ketones, ethers, esters and mixtures thereof. In particular, claim 1 is amended to define a process for treating a membrane of the type used in gas separation or pervaporation, the membrane being comprised of polyimide, the process comprising the steps of directly exposing the polyimide to a dendrimer in a solvent, and maintaining the solvent containing said exposed polyimide and said dendrimer at a temperature of less than 100°C and for a time to allow the dendrimer to crosslink the polyimide. Support for this amendment can be found at page 2, lines 23-24 and at page 3, lines 11-19 and 20-24 of the specification.

Rejection under 35 USC 102(b)

The Examiner rejected claims 18-28 as being anticipated by WO 99/40996. These claims are cancelled and Applicant respectfully requests withdrawal of this rejection.

Rejection under 35 USC 103

The Examiner rejected claims 1, 3-5 and 7-15 as being unpatentable over WO 99/40996 (document D1).

Applicant respectfully submits that claims 1, 4, 5 and 8-15 are not obvious having regard to document D1, for at least the following reasons.

The present invention, as defined by the amended claims, provides a treated polyimide membrane having high selectivity and high has permeability which is suitable for use as a gas separation membrane or as a pervaporation membrane. Amended claim 1 sets forth the steps of directly exposing the membrane of the type used in gas separation or pervaporation, the membrane being comprised of polyimide, to a dendrimer in a solvent, and maintaining the solvent containing said exposed polyimide and said dendrimer at a temperature of less than 100°C and for a time to allow the dendrimer to crosslink the polyimide.

Document D1 teaches a process for forming selective composite membranes. The process comprises providing an asymmetric membrane base having pores in at least the upper layer thereof, and exposing the porous membrane base to a coating solution. The membrane base can be a polyimide membrane. The coating solution comprises polymers (which can also be a dendritic polymer, see page 33 lines 8 to 22 of Document D1) and/or oligomers, which forms a selective barrier coating on the surface of the membrane base and on the surfaces of the pores within the membrane base. Crosslinking agents such as non-polymeric or

oligomeric polyfunctional compounds can be added to the coating solution to crosslink the polymers and/or oligomers.

A Declaration by Professor Chung, who is one of the inventors for the present invention, is enclosed.

Referring to Statement 6 of the Declaration, the feature of directly exposing the membrane of the type used in gas separation or pervaporation, the membrane being comprised of polyimide, to a dendrimer is not taught nor disclosed in Document D1.

Furthermore, referring to Statement 7 of the Declaration, the process, as defined by the present claims, results in surface modification (i.e. only the surface of the membrane is crosslinked) of the polyimide membrane, and not the formation of a separate selective barrier coating on the polyimide membrane base as taught in Document D1.

Referring to Statement 8 of the Declaration, it should be noted that in the process of Document D1, the membrane base has to be a porous asymmetric membrane base, which when treated, is suitable for use as a Reverse Osmosis (RO) membrane, Nano-filtration (NF) membrane, Ultra-filtration (UF) membrane or Electrodialysis (ED) membrane. Such membranes are generally employed for the separation of liquid mixtures and are not suitable for separating gas mixtures in view of their pore sizes. For instance, the pore sizes of RO, NF and UF membranes are typically 0.7nm, 1-10nm and 20-200 nm respectively, which are too large for gas separation or pervaporation purposes. Accordingly, the feature of the polyimide membrane being in the form of a gas separation membrane is also not taught or suggested at all in Document D1.

The direct exposure of the membrane of the type used in gas separation or pervaporation, the membrane being comprised of polyimide, to a dendrimer under the defined conditions results in a treated polyimide membrane having high gas permeability and high selectivity, as can be seen in Examples 1 to 3 on pages 9-15 of the present application and is also confirmed by Professor Chung in Statement 10 of his Declaration.

Referring to Statement 11 of the Declaration, although crosslinking can modify the polyimide membrane to result in improved selectivity, it can also result in densification of the membrane which in turn reduces permeability. As gas separation membranes or pervaporation membranes are generally of a dense structure, the dendrimer cannot penetrate deep into the membrane structure and the crosslinking reaction is therefore limited to the surface of the membrane. Accordingly, the bulk of the membrane structure below the crosslinked membrane surface remains unmodified or undensified. The polyimide membranes treated with the process as defined by the claims of the Application therefore have a high selectivity and high gas permeability.

The technical advantages outlined in Statements 10 and 11 of the Declaration resulting from the process as defined by the present claims are not taught or suggested at all in Document D1.

As confirmed by Professor Chung in Statement 8 of his Declaration, Document D1 does not teach a process for treating gas separation membranes, as it is an essential requirement in the process of Document D1 that the membrane base be porous. Furthermore, Document D1 also does not suggest the use of the disclosed selective composite membranes in

the separation of gas mixtures or in pervaporation. Accordingly, a skilled technician who is knowledgeable in the field of membrane technology would not be readily motivated to try or would not understand that the process as disclosed in Document D1 can be applied to a membrane of the type used in gas separation or pervaporation, the membrane being comprised of polyimide.

Referring to Statement 14 of the Declaration, in the process disclosed in Document D1, the coating solution penetrates into the pores of the membrane base by means of convection and diffusion mechanisms, thereby resulting in the crosslinking of the polymers and/or oligomers (in the coating solution) occurring on both the surfaces of the membrane base and the pores within the membrane base to form the selective barrier coating.

On the other hand, as mentioned in Statement 11 above, in the process as defined by the present claims, the dendrimers react only with the surface of the membrane. Only an insignificant amount of the dendrimers may penetrate underneath the surface by diffusion.

In Statement 16 of his Declaration, Professor Chung is of a view that a person skilled in the art, in reading the disclosure of WO 99/40996, will not be motivated to or be able to derive the present invention as defined by the presently amended claims. In his Statement, Professor Chung is also of the view that the claims are not obvious in light of the disclosure of WO 99/40996. Claims 1, 4, 5, 8 to 15, 17, 29 and 30, in their current forms, are therefore inventive over Document D1.

Therefore in view of the foregoing, Applicant respectfully requests withdrawal of this rejection, and allowance of claims 1, 4, 5, 8 to 15, 17, 29 and 30, as currently presented, is earnestly solicited in view of the above.

Remaining Claim Amendments

Claims 4, 5, 13 and 15 are amended to replace the word "compound" with "dendrimer" in keeping with the amendments to claim 1. Claim 13 has also been amended to correct the term "an solvent" to read "a solvent". Claims 8 and 9 are amended to depend from claim 1. Claim 29 is added to define the feature of the solvent as previously defined in claim 1. That is, claim 29 specifies that the solvent is selected from the group consisting of alcohols, ketones, ethers, esters and mixtures thereof. Claim 30 is added to define the dendrimer as being generation 0 or 1. Support for this amendment is found at page 6, line 11 of the specification and in claim 9. It is believed that no new matter will be added by these amendments.

Applicant respectfully requests withdrawal of the rejections and allowance of the application.

Respectfully submitted,

KLARQUIST SPARKMAN, LLP

By:_____
Richard J. Polley
Registration No. 28,107

One World Trade Center
121 S.W. Salmon Street, Suite 1600
Portland, Oregon 97204
Telephone: (503) 226-7391
Facsimile: (503) 228-9446